

**NOAA TIME CENTER REPORT:  
FY2003 PROGRESS AND PROPOSED FY2004 PLANS AND BUDGET**

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## **Background**

The TIME Center provides NTHMP partner States and Federal Agencies with scientific, technical and programmatic support. State Mapping Teams and the NOAA TIME Center work collaboratively toward a major NTHMP goal -- develop a tsunami inundation map and related Emergency Management products for every at-risk coastal community. State mapping efforts are supported through the acquisition, quality control, and merger of bathymetric/topographic data to develop the necessary computational grids; this includes communicating NTHMP data survey priorities to the National Ocean Service, USGS, NASA and other Federal and State agencies, working closely with them to coordinate survey coverage, and developing agreements for early delivery of survey data to the TIME Center. TIME continues to work with the States to develop standards for map development, quality control procedures, and certification criteria. TIME Center scientists actively engage the wider tsunami community to promote research relevant to NTHMP goals and to import and apply mature technologies to NTHMP problems. Finally, Washington State continues to fund the TIME Center for inundation modeling studies and the development of Emergency Management products for high-priority Washington communities. This report summarizes FY2003 Progress and Proposed FY2004 Plans and Budget.

## **Alaska**

The Alaska Division of Emergency Services directs the Alaska Tsunami Mapping Team, which initiated a program in FY03 to accelerate the development of inundation maps, made possible by an increase in Alaska mapping funds. The University of Alaska in Fairbanks is contracted to perform the modeling for this effort, and Alaska has supplemented TIME Center funding to accelerate the acquisition, quality control, and merger of bathymetric/topographic data to develop the necessary computational grids. TIME is also working closely with the National Ocean Service to accelerate bathymetric multibeam surveys and bathy/topo LIDAR surveys in high-priority Alaska areas. As a result, surveys of two high-priority areas -- Sitka and Sand Point -- have been scheduled or completed. The TIME Center will continue to collaborate with the Alaska Tsunami Mapping Team to accelerate inundation map development.

### ***FY03 Progress.***

- |                                 |                                    |
|---------------------------------|------------------------------------|
| • Seward grid system:           | 4 grids developed; 2 grids updated |
| • Sitka grid system:            | 3 grids developed                  |
| • Yakutat grid system:          | 3 grids developed                  |
| • Sitka-Yakutat regional grids: | 2 grids developed                  |
| • Sand Point LIDAR survey:      | Completed. TIME awaiting delivery. |
| • Homer-Seldovia modeling:      | Near completion                    |

### ***FY04 Plans***

- |                                 |  |
|---------------------------------|--|
| • Whittier or Sand Point (TBD): | Grid system development  |
| • Seward inundation modeling:   | Underway   |
| • Prince William Sound:         | Vertical datum study   |
| • Sand Point Hydro survey:      | FY04 multibeam bathymetry scheduled  |
| • Sitka Hydro survey:           | FY04-05 multibeam bathymetry scheduled   |
| • Data:                         | Continue acquisition efforts; availability analyses; quality control; priorities and scheduling assistance |

Whittier will likely be the next modeling effort. Unlike previously modeled communities, it is located within one of the many arms of Prince William Sound. As was the case for TIME Center modeling in Puget Sound, the complex tidal dynamics give rise to datum problems during grid development. Therefore, before adequate computational grids can be developed for Whittier or any of the other high priority communities in the Sound, including Cordova and Valdez, a tidal datum analysis must be performed. For such studies, one or more of three methodologies are used: tidal model harmonic constants; a Vdatum tool of the NOAA Ocean Services Center; tidal correction tables and tertiary station information for recent NOS survey operations.

### **California**

The California Office of Emergency Services contracts inundation modeling with the University of Southern California, which uses a numerical model implemented at USC by the TIME Center – i.e., the Method of Splitting Tsunamis (MOST) model developed by Vasily Titov. TIME scientists support the USC modeling effort by development of the necessary merged bathymetric/topographic computational grids, including data acquisition and quality control. In addition, the TIME Center provides upgrades to the MOST model and scientific and technical assistance in the application of the model, as needed. Northern California area has been identified as the next priority area, and the TIME Center will assist USC in this effort with scientific and technical support, as needed.

### ***FY03 Progress***

- |                                    |                                     |
|------------------------------------|-------------------------------------|
| • MOST model upgrade:              | Transferred latest version          |
| • Central California grid system:  | 10 grids developed                  |
| • San Francisco Bay grid system:   | 4 grids developed, more work needed |
| • Orange County modeling:          | Near completion                     |
| • Ventura County modeling:         | Near completion                     |
| • San Luis Obispo County modeling: | Underway                            |
| • San Francisco Bay modeling:      | Underway                            |

### ***FY04 Plans***

- MOST model upgrade: Transfer upgraded version
- San Francisco Bay grid system: Complete development and deliver
- N. CA (Crescent C., Eureka) modeling: Support, as needed
- San Francisco modeling: Support, as needed
- Orange Cty. modeling: Support, as needed
- Ventura Cty. modeling: Support, as needed
- S. Luis Obispo Cty. modeling: Support, as needed

### **Hawaii**

The Hawaii Civil Defense Division directs the Hawaii modeling and mapping effort, and has initiated a systematic program to upgrade the existing tsunami inundation maps, which are based on 1-dimensional modeling techniques, using the more advanced 2-dimensional inundation modeling technology. TIME Center scientists provide scientific and programmatic support for the Hawaii mapping program and will continue to do so in FY04.

### ***FY03 Progress***

- TIME scientists made a presentation to the Hawaii Tsunami Technical Review Committee on future development of the Hawaii modeling and mapping program, with a strong recommendation to identify a State geotechnical person to actively participate and assume responsibility for assisting with technical oversight of inundation modeling and for the subsequent development and publication of evacuation maps.
- The Hawaii Department of Land and Natural Resources has identified an individual to serve on the NTHMP Steering Group and actively participate and contribute to the Hawaii modeling and mapping program.
- Based on previously funded work, a number of sites have been identified as high-priority areas for the inundation map updates, including Kaiaka Bay, Hawaii Kai, and Kaena-Haleiwa, on the island of Oahu; Kahului Harbor, Maui; Haena-Hanalei, Kauai; and Kailua Bay and Hilo Bay, on the island of Hawaii.

### ***FY04 Plans***

- Establish contract for inundation modeling studies.
- Inundation modeling studies of two communities. The TIME Center will provide Hawaii modeling contractor with scientific and technical assistance, as needed.

## **Oregon**

The Oregon Department of Geology and Mineral Industries conducts inundation modeling studies with the numerical model developed by the Oregon Graduate Institute. The Oregon modeling and mapping program is somewhat mature, because DOGAMI had been developing inundation and evacuation maps before the NTHMP was formed, and because the first year of NTHMP resources were focused entirely on this state and Washington. Thus, a number of modeling studies of Oregon and Washington communities were conducted during the first several years of NTHMP, before a systematic archiving program had been established at the TIME Center. Rescue efforts are now underway to locate and archive the model input and output data from these earlier studies. The TIME Center has been working on this problem with DOGAMI, the Washington Department of Natural Resources, the OGI and the two scientists who conducted these modeling studies, Edward Myers and Robert Kamphaus, each of which have since left their respective organizations for other positions. Some data have been recovered, but it is possible that other data have been irretrievably lost; in other cases, e.g., where new modeling studies are planned, the rescue effort will be unnecessary. TIME will continue to support the Oregon modeling and mapping efforts, as needed.

### ***FY03 Progress***

- Alsea Bay, Waldport modeling completed by DOGAMI. Model output data delivered to TIME. Report in press.
- Alsea Bay TIME Center support: provided tsunami source information from archived Newport study; reviewed results; archived model output.
- Data rescue: CDs delivered to Ed Myers for his investigation and summary, to guide additional effort

### ***FY04 Plans***

- Data rescue: TIME will investigate tapes that were archived by Kamphaus, and continue to work with Myers, OGI and DOGAMI to organize the effort.
- Data acquisition and quality control, as needed for grid development and modeling

## **Washington**

The Washington State Emergency Management Division directs the inundation modeling and mapping program. As with other States, the TIME Center provides scientific, technical and programmatic support for this effort, including the acquisition, quality control, and merger of bathymetric/topographic data to develop the computational grids. In addition, Washington contracts with the TIME Center to perform inundation modeling studies and assist in the development of emergency management products for high-priority communities. For this reason, the TIME organized and conducted a joint Washington State, USGS, NOAA workshop in 2002, to assess and document the best available science regarding potential sources in Puget Sound.

### ***FY03 Progress***

- Puget Sound Tsunami Sources: Published Workshop Report (González, et al., 2003)
- Seattle modeling study: Final Report in press (Titov, et al., 2003a)
- Seattle inundation map: Published (Walsh, et al., 2003c)
- Straits of Juan de Fuca modeling: Completed. Anacortes, Bellingham, NW Whidbey
- Tacoma grid system: 2 grids completed.
- Qileute inundation map: Published (Walsh, et al., 2003a)
- Neah Bay inundation map: Published (Walsh, et al., 2003b)
- Other contributions to WA Program:
  - March 15, 2003 Meeting. EMD State/Local Tsunami Working Group. Provided tsunami information to Washington State and county emergency agencies.
  - October 24, 2002 Meeting. State Seismic Safety Committee. Provided tsunammi technical advise. The committee makes recommendations to State on seismic safety issues.
  - October, 2002 Meeting. Puget Sound Ports Safety & Security Committee. Provided tsunami information. This committee serves interagency role.
  - State Hazard Profile input. Helped develop the tsunami and seiche sections for State HIVA report to FEMA.

### ***FY04 Plans***

- Ocean Shores-Long Beach: Data availability, quality report
- OS-LB or Tacoma (TBD): Grid development
- OS-LB or Tacoma (TBD): Inundation modeling study
- OS-LB Engineering study: If modeled, coordinate as needed
- Jefferson County evacuation map: Underway
- Clallam County evacuation map: Underway
- Pacific County evacuation map: Revise
- MOST Model Implement upgrade
- Landslide sources Add to MOST model capability

## NTHMP - Additional FY2003 Progress

The TIME Center, aided by a broad perspective gained through active involvement in the very different modeling and mapping programs of each State, and through continuing scientific and programmatic support of the DART Project, conducts a number of activities that support the technical and programmatic goals of NTHMP as a whole. These are summarized below.

### *Modeling and Mapping*

- *Standards development.* APPENDIX A, “Toward Standards and Certification Procedures for Inundation Modeling and Mapping Products” provides a set of recommendations on the organization, planning, implementation and completion of an inundation modeling and mapping effort. This is a shortened version of a more detailed discussion in Gonzalez et al., (2004a).
- *Grid development technology.* TIME continues to improve grid development with new conversion methodologies and quality control procedures (Venturato, 2003a). A systematic approach to resolving datum differences between disparate elevation data sources has been developed, and reports have been prepared regarding this problematic data conversion issue (Mofjeld, et al., 2002; Mofjeld, et al., 2003a).
- *GIS Applications.* Pervasive use of GIS systems by State Agencies, Federal Agencies and inundation modelers attest to the power this tool brings to the integration, manipulation, processing, visualization and analysis of disparate databases to meet the needs of scientists, operational personnel and emergency managers. This has made it essential for the TIME Center to adopt and exploit this technology (Venturato, 2003b). All inundation modeling products delivered to the State of Washington are now GIS compatible and, increasingly, data and computational grids are requested by inundation modelers in GIS format. TIME Center activities related to GIS applications include
  - At-Risk Population Estimator. Filters Census 2000 block data. Current filtering by distance from the coast. Elevation filter is planned. Filter to use model-derived inundation line is planned.
  - Casualty Estimator. Koshimura et al. (2003) have combined Seattle inundation modeling results with a hydrodynamic force model to estimate tsunami casualties. Koshimura was a visiting scientist at the TIME Center, and TIME will continue to track this research for possible implementation as a GIS application.
  - Web-Map Calculator. This application will make intra- and inter-layer computations to produce and display products in a GIS environment accessed by an internet web browser. TIME has provided developers Nazila Merati (PMEL) and Tiffany Vance (NMFS) with the At-Risk Population Estimator and other algorithms, GIS-compatible files of Seattle inundation modeling output, and assistance preparing the proposal funded for this effort (Vance, et al., 2002).



## ***Warning Guidance***

- *DART Project.* The TIME Center continues to provide scientific and programmatic support to this effort (González, et al., 2004b). Some activities directly related to this effort:
  - NDBC Assistance. TIME continues to assist NDBC with issues of data stream processing, archiving, and web page development. The current effort involves development, testing and transfer of an algorithm for real-time removal of tides, in order to clearly identify a tsunami signal.
  - System Functionality. TIME works with the PMEL Engineering Development Division to develop data needs and other functional requirements, as DART systems continue to evolve, including issues of bi-directional communication and download capabilities for DART data recovery.
  - Network Expansion. International participation would help to expand the network. Presentations that emphasize the value of DART systems are regularly provided at appropriate workshops and meetings (see Programmatic section, below).
- *Tsunami Forecasting System.* TIME leads a collaborative effort with the NOAA Tsunami Warning Centers and the University of Hawaii to develop and implement a tsunami forecast system that will integrate and interpret real-time seismic, DART and tide gage data with numerical modeling technology. This effort was first funded by the NTHMP in the latter part of FY2003, and a report has been prepared to summarize FY03 Progress and FY04 Plans (González, et al., 2003). Some important activities related to this effort:
  - Workshops. Two tsunami forecasting workshops have been conducted:
    - 21 January 2003 Workshop in Seattle, Washington. Dealt primarily with technical issues of development and implementation (González, et al., 2003b).
    - 13 March 2003 Workshop in Honolulu, Hawaii. Dealt primarily with Emergency Management issues, as a follow-up to 21 January workshop.
  - Development of Tide Gauge Real-time Data Requirements. Needed to guide requested upgrade of NOS tide gauge network. Transmittal to NOS is planned (see González, et al., 2003c).
  - Data Rescue. Tsunami event data are essential for the case studies that must be conducted to test and improve the tsunami forecasting system. The relative infrequency of tsunamis makes this effort particularly urgent. Some efforts underway:
    - DART – Download capability for the acquisition of tsunami time series a short time after the event.
    - Tide gauges – Currently, TIME scientists rescue these data by electronic download or by ad-hoc procedures that use local volunteers to physically remove and mail data storage devices back to NOS. The 25 September

2003 Hokkaido event was the most recent effort, in which more than 25 tide gage records were downloaded and archived (Bernard, et al., 2003).

- Data Compilation Web Page – TIME posts all event data on a Data Compilation web site, announces its availability, and encourages contributions of all relevant information for the international community.
- Journal Article. A report providing a summary and overview of the tsunami forecasting development effort is in review for publication in a special issue of the Natural Hazards Journal (Titov, et al., 2003b)

### ***Programmatic***

These efforts, primarily in the form of presentations and discussions at workshops and meetings, are aimed at (1) communicating NTHMP research needs to scientists and funding agencies, to encourage active contributions to NTHMP goals, (2) encouraging international participation in the expansion of the DART network.

- April 7, 2003 First International Symposium on Submarine Mass Movements and Their Consequences. Presentation by Titov on “Real-Time Tsunami Forecasting: Challenges and Solutions. Nice, France.
- July 10, 2003 IUGG 2003 Session - Tsunamis: Their Science, Engineering and Hazard Mitigation. Presentation by Titov on “Assessing Tsunami Magnitude for Inundation Forecast.” Sapporo, Japan.
- July 10, 2003 IUGG 2003 Session - Tsunamis: Their Science, Engineering and Hazard Mitigation. Presentation by González on “U.S. NTHMP Efforts to Develop Far-Field Tsunami Forecast Guidance Tools.” Sapporo, Japan
- August 8, 2003 First Workshop for an Integrated Tsunami Scenario Simulation, Oregon State University. Made presentation on potential linkages of this and other programs, such as the NSF NEES initiative, to the NTHMP. Stressed the need for technology transfer as an essential component of research efforts to address NTHMP goals.
- August 6, 2003 Fifth Conference on Coastal Atmospheric and Oceanic Prediction and Processes. Presentation on NTHMP Hazard Assessment and Warning Guidance, “Progress on Improved Operational Forecasting and Inundation Mapping of Pacific Tsunamis for Coastal Communities” and stressed the need for research to meet NTHMP goals.
- September 25-26, 2003 Workshop on Tsunamis in the South Pacific, Wellington, New Zealand. Presentations and discussions on NTHMP Hazard Assessment component and NTHMP Warning Guidance component.
- September 29, 2003 ITSU XIX - Nineteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific. Wellington, New Zealand. Presentation and discussion of TROIKA, a plan to establish an International Tsunami Hazard Mitigation Program.

- October 20, 2003 USGS/UW Workshop on Geologic Research in the Seattle Area. University of Washington, Seattle, WA. Communicated NTHMP needs for source identification and characterization for inundation modeling and mapping studies.
- October 21, 2003 USGS/UW Engineering Workshop - Update on Current USGS Earthquake Hazard Studies in Puget Sound. University of Washington, Seattle, WA. Presented overview of NTHMP Hazard Assessment component, including potential value of modeling output for estimating tsunami impacts on structures and humans, emphasized need for development of algorithms to exploit these data.
- December 1-2, 2003 Sixth Multi-lateral Workshop on Development of Earthquake and Tsunami Disaster Mitigation Technologies and its Integration for the Asia-Pacific Region (6th EqTAP WS) organized by Earthquake Disaster Mitigation Research Center, NIED. Ise-Kashikojima, Japan. Invited presentation on NTHMP Program. Will stress need for international participation in NTHMP Warning Guidance component.
- December 9, 2003. AGU Session: Progress in Tsunami Research and Mitigation. Will present “NTHMP Product Example: Tsunami Forecasting” stressing progress, challenges and need for applied research on tsunami forecasting.

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## Proposed FY2004 Plans and Budget

### *FY2004 Plans*

Table 1 provides a summary of proposed products and support activities, based on FY04 State Plans and the continuation of ongoing activities that support all NTHMP partners.

**Table 1.** Summary of TIME Center FY04 Plans and Deliverables.

<b><u>Partner</u></b>	<b><u>Product or Support Activity</u></b>
<b>Alaska</b>	<ul style="list-style-type: none"> <li>• Whittier or Sand Point (TBD): Grid system development</li> <li>• Seward: Support modeling, as needed</li> <li>• Prince William Sound: Vertical datum study</li> <li>• Sand Point &amp; Sitka: Continue acquisition efforts; availability analyses; quality control; priorities and scheduling assistance</li> </ul>
<b>California</b>	<ul style="list-style-type: none"> <li>• San Francisco Bay grid system: Complete development and deliver</li> <li>• MOST model upgrade: Transfer latest version</li> <li>• Modeling: Support, as needed               <ul style="list-style-type: none"> <li>○ S. Luis Obispo Cty.</li> <li>○ San Francisco</li> <li>○ Orange Cty.</li> <li>○ Ventura Cty.</li> <li>○ N. CA (Crescent City, Eureka, ...)</li> </ul> </li> </ul>
<b>Hawaii</b>	<ul style="list-style-type: none"> <li>• Model 2 communities: Support, as needed</li> <li>• Programmatic issues: Assist as needed</li> </ul>
<b>Oregon</b>	<ul style="list-style-type: none"> <li>• Data rescue: Locate available OGI data &amp; archive</li> <li>• Modeling &amp; data acquisition: Assist, as needed</li> </ul>
<b>Washington</b>	<ul style="list-style-type: none"> <li>• Ocean Shores-Long Beach: Data availability, quality report</li> <li>• OS-LB or Tacoma (TBD): Grid development</li> <li>• OS-LB Engineering study: If modeled, coordinate as needed</li> <li>• MOST model: Implement upgrade</li> <li>• Landslide sources: Add to MOST model capability</li> </ul>

<p><b>All NTHMP Partners</b></p>	<p>Continue:</p> <ul style="list-style-type: none"> <li>• Standards and certification development</li> <li>• Archive and web site development; Establish model data formats</li> <li>• Grid development technology improvements</li> <li>• Coordination with NOS, USGS and other data survey agencies</li> <li>• Communication of research priorities to tsunami community</li> <li>• Development of GIS-based model products</li> <li>• Coordination with FEMA HAZUS effort, as needed</li> </ul>
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***FY2004 Budget***

Funding of \$300K is sought toward labor and other costs of 2.7 effective full time (EFT) personnel. This is approximately 64% of the total funding required. The remaining 36%, or \$166K, will be provided by NOAA.

<b>Item</b>	<b>NTHMP (K\$)</b>	<b>NOAA (K\$)</b>	<b>Totals (K\$)</b>
Labor: Director, Sr. Scientist, Modeler, Modeler Asst., Data/GIS Spec. (2.7 EFT)	278.0	127.7	405.7
Computer	12.0	15.0	27.0
Hardware & Software		13.0	13.0
Publications	5.0	5.0	10.0
Travel	5.0	5.0	10.0
<b>Total Cost</b>	<b>300.0</b>	<b>165.7</b>	<b>465.7</b>



## **APPENDIX A: Toward Standards and Certification Procedures for Inundation Modeling and Mapping Products**

Prepared for the U.S. National Tsunami Hazard Mitigation Program Steering Group Meeting  
November 6-7, 2003, Seattle, WA

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### ***Background***

The TIME Center provides scientific and technical support to inundation modeling and mapping programs in Alaska, California, Hawaii, Oregon and Washington. TIME Center involvement in the Washington State and Alaska State programs have been especially instructive. Based on this experience, a set of practices, procedures and products have been developed and applied to modeling studies conducted by the TIME Center for Washington State and in the efforts of the Alaska program to accelerate grid development, modeling and mapping.

A fundamental tension can arise in this process but, if properly managed, can be harnessed as a positive force. Scientists naturally strive for ever higher quality and utility, but this must be tempered by the reality of limited time and resources. Emergency Managers naturally strive for rapid and complete coverage of all coastal communities, but this must be tempered by the need for scientifically credible and defensible products. This can create a fundamental tension in which difficult judgments, decisions and trade-offs between quality and production are inevitable. The State Geotechnical official is clearly key to this process -- a scientist with responsibility for achieving State mandates and goals. Ultimately, final decisions must be made by the State Emergency Management official, guided by the State Geotechnical official and modeling team scientists. The TIME Center finds that, although every modeling and mapping project is different, the effort benefits from the set of recommendations presented, below.

These recommendations are only a start – they deal only with issues of team organizational structure, and the process of planning, implementing and completing an inundation modeling and mapping study. Not addressed here are other fundamentally important issues that must be dealt with if comprehensive standards for modeling and mapping are to be established. Technical issues remain – Quality Control, Error Assessment, and Quality Indices for both grid development and model products. The final issue also remains – one with policy, procedural and technical components – that of establishing official NTHMP Certification.

### ***Recommendations***

- **1.** *A State Emergency Management official* should direct the effort, bearing ultimate responsibility for setting priorities.
- **2.** *A State Geotechnical official* (State equivalent of a USGS official) should serve as the State technical adviser to the State Emergency Management official, contribute to technical issues of the modeling effort, and bear responsibility for development and publication of inundation and evacuation maps.

- 3. *Timely delivery of scientifically credible products* should drive the effort, with development taking priority over research.
- 4. *Community Prioritization* should involve a systematic process of assessing community characteristics to rank need and potential success of a Hazard Assessment effort. The prioritization matrix developed by the Alaska Tsunami Mapping Team is an excellent example (Table 1).
- 5. *Source Identification* should involve an intensive, highly focused workshop to systematically inventory and document the best available scientific information on potential tsunami sources in a region. An example of this is the recent Puget Sound Tsunami Sources Workshop jointly organized by Washington State, the USGS, and NOAA (González, et al., 2003).
- 6. *Computational Grid Development* should (a) aim to create fine-scale inundation grids of 50m resolution or less if important, site-specific inundation features are to be identified (NTHMP Steering Group Meeting Report, 2001), (b) conduct an intensive effort to acquire State and local data, and (c) resolve vertical and horizontal datum differences in a careful, systematic manner.
- 7. *Milestone Meetings* of the entire Hazard Assessment team should make and document team decisions that are needed to achieve key milestones. Some recommended milestones, advance materials required, and issues that call for team decision-making are as follows.

○ Milestone: Define scope of the effort

Material: Inventory of bathymetric and topographic data  
Potential tsunami source information

Issues: Adequacy of available bathymetric and topographic data  
Geographical extent of computational grid system  
Communities to be modeled at the finest resolution  
Source specification  
Probable scientific credibility and utility of effort  
Deliverable products  
Schedule

○ Milestone: Critique preliminary model runs

Material: Graphics of results  
Modeler's brief interpretive narrative and recommendation

Issues: Assessment of scientific credibility and utility  
- General reasonableness  
- Consistency with available historic and pre-historic data  
Impact of proposed improvements on resources and schedule  
Production plan and schedule

- Milestone: Critique products
  
- Material: Deliverable products in graphic and tabular form
  
- Issues: Impact of modifying or adding products  
 Final acceptance  
 Documentation plan  
 Schedule for delivery
  
- 8. *Inundation modeling products* should be provided as hard-copy graphics and digital data and graphic files on a CD-ROM that are GIS-compatible, and should include (Titov, et al., 2003):
  - Animation of Simulations
  - Shoreline Vectors
  - Bathymetric/Topographic Grids
  - Source Deformation
  - Maximum Wave Heights
  - Maximum Water Depth On Land
  - Maximum Current Speeds
  - Inundation Line Vectors
  - Zoned Maximum Water Depth on Land (Low, Med, Hi)
  - Zoned Maximum Current Speeds (Low, Med, Hi)
  - Time series at selected stations
  - ArcView Project Module
  - Metadata files
  - Documentation in the form of a Product Report
  
- 9. *A Final Inundation Modeling Study Report* should be provided to the State after the acceptance and delivery of all digital and graphical products (Titov, et al., 2003).
  
- 10. *Inundation and evacuation maps* based on the inundation modeling study should be developed and published by the State, and consultations with the inundation modeler should be available to the State during this effort, as needed, to clarify technical issues.
  
- 11. *Archival copies* of all modeling and mapping products should be delivered to the NOAA TIME Center.

## ***References***

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**Table 1.** The Alaska Department of Emergency Services organized a review by the Alaska Hazard Assessment team of candidate communities for inundation numerical modeling. The communities were discussed and rated, guided by the criteria indicated.

Community	Tsunami Potential	Community Involvement	Bathymetry *	Population	Infrastructure	Tourism	Cruise Ships (Tour Bus/Ship)	Special Seasonal Events	Commercial Fishing / Timber	Large Scale USGS Base Maps
<b>Cold Bay</b>			2	103	✓			✓	✓	
<b>Cordova</b>			3	2571	✓	✓	✓	✓	✓	✓
<b>Homer</b>	✓	✓	1	4155	✓	✓	✓	✓	✓	✓
<b>Seldovia</b>	✓	✓	1	281	✓	✓	✓	✓	✓	✓
<b>Ketchikan</b>		✓	2	8460	✓	✓	✓	✓	✓	✓
<b>King Cove</b>			2	1947	✓			✓	✓	
<b>Petersburg</b>			3	3398	✓	✓		✓	✓	
<b>Sand Point</b>	✓	✓	2	830	✓			✓	✓	
<b>Seward</b>	✓	✓	3	3090	✓	✓	✓	✓	✓	✓
<b>Sitka</b>	✓	✓	2	8779	✓	✓	✓	✓	✓	✓
<b>Unalaska</b>	✓	✓	1	4285	✓	✓	✓	✓	✓	
<b>Valdez</b>	✓		2	4155	✓	✓	✓	✓	✓	✓
<b>Whittier</b>	✓	✓	1	306	✓	✓	✓	✓	✓	✓
<b>Wrangell</b>			2	2589		✓	✓		✓	
<b>Yakutat</b>			1	810	✓	✓		✓	✓	✓
<b>Elfin Cove</b>			2	50		✓			✓	
<b>Ouzinkie</b>	✓		2	252	✓	✓		✓	✓	
<b>Port Lions</b>			2	242	✓	✓		✓	✓	
<b>Akutan</b>			1	408				✓	✓	
<b>Perryville</b>			2	107				✓	✓	
<b>Adak</b>			1-2	7	✓				✓	
<b>Shemya</b>			1	0						
<b>Nikolski</b>				35						
<b>Juneau/Douglas</b>			3	30684	✓	✓	✓	✓	✓	✓
<b>Skagway</b>			3	814	✓	✓	✓	✓		✓
<b>Craig</b>			3	2145	✓	✓		✓	✓	✓
<b>Haines</b>			3	1463	✓	✓	✓	✓	✓	✓

\* Bathymetry data availability scale: 1 – Good, 2 – Some 3 – Poor